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Fossil Plants of Class Pinopsida from the Neogene Sediments of Satovca Graben in Rhodopes Region (Southwest Bulgaria)

by E. PALAMAREV, K. USUNOVA & I. BOJANOVA

Zusammenfassung

Die fossilen Koniferen von Satovca Graben im Rhodopen Gebiet (Südwestbulgarien) werden hier beschrieben und besprochen. Die fossilführenden Ablagerungen sind wahrscheinlich mittel- bis obermiozänen Alters und weisen 14 Arten auf, die zu den Gattungen *Pinus, Tsuga, Sequoia, Cryptomeria, Sciadopitys, Tetraclinis, Libocedrites, Thuja* und *Amentotaxus* gehören.

Summary

Described and analysed are the fossil Conifers recovered in the Satovca Graben in Rhodopes region (Southwest Bulgaria). The fossil-bearing deposits are probably of Middle to Upper Miocene age. Proved is the occurrence of 14 species of the genera *Pinus, Tsuga, Sequoia, Cryptomeria, Sciatopitys, Tetraclinis, Libocedrites, Thuja* and *Amentotaxus*.

Contents

1. Introduction

Satovca Graben is to be found on the southern flank of the western Rhodopes, northeast of the village of Satovca, Goce Delcev district (fig. 1). Its Tertiary rocks are placed in a band, pointing to the north-northeast, the best cross section being followod in its central part: the paces known as "Sivik" and "Belite bregove".

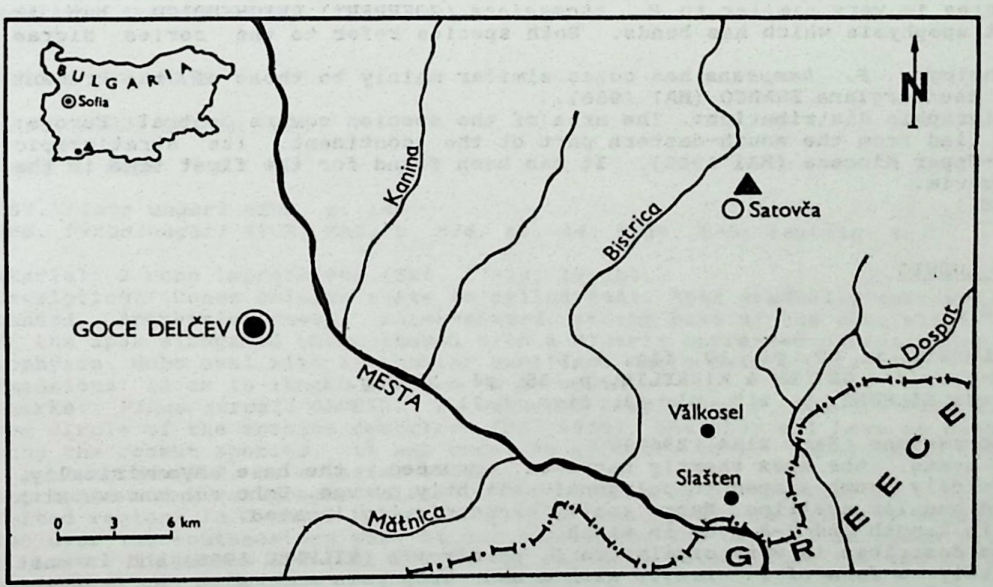

Fig. 1. Sketch-map of the area investigated

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The geological age of the sediments is a matter of discussion. JARAVOV (1943) and BORISSOV et al. (1973) define the age as Oligocene. PIRUMOVA & VACEV (1979) fix to a part of the the deposit complex Sarmatian age, and later VACEV & PIRUMOVA (1983) differentiate two formations: Satovcanska and Siviska. The rocks of the former are referred to the Early Oligocene while those of the latter go to the Middle-Late Miocene.
Fossil-bearing are the sediments of the Siviska formation (Sf). They are represented by a pack of sandstones with layers of diatomites, clayey siltstones and clays with an overall thickness of about 120 m. Coal interbeds occur in them irregularly. They lay upon the Oligocene rhyodacites and rhyolites.
The fossil flora ist extremely rich, including index species of different systematic groups that will make possible a paleofloristic reasoning of the age, but only after an overall treatment of the paleoflora.
In the Institute of Botany at the Bulgarian Academy of Sciences a collection is kept from that formation unique in its composition and richness of paleoflora, comprising about 5000 specimens. Its major part was collected by Prof. D. JORDANOV and P. HADZIEV in the the years 1958 to 1967, and in the last three years of the same period E. PALAMAREV also took part in the field investigations.
The data published so far on the composition of the paleoflora are very scarce. All the comprise are 4 taxa, described by STEFANOFF & GANCEFF (1951), belonging to the genera *Cinnamomum, Alnus, Stewartia* and *Gordonia*.
This paper includes the results of the taxonomic study of the specimens of the Conifers.

2. Description of the species

For the elaboration of the fossil species of the genus *Pinus* the system is used that was applied by VAN DER BURGH (1973) and MAI (1986), based for its part on the system suggested by LITTLE & CRITCHFIELD (1969).

2.1. Pinaceae

PINUS LINNÆ
Section *SYLVESTRES* VAN DER BURGH (*EUPITYS* SPACH p.p.)

2.1.1. *Pinus hampeana* (UNGER) HEER

Plate 1, figs. 4-5

1847. *Pitys hampeana* UNGER, p. 78, pl. 20, figs. 1-3
1855. *Pinus hampeana* (UNGER) HEER, p. 56, pl. 20, fig. 4
1873. *Pinus polonica* STUR, p. 7 (nom. nudum)
1928. *Pinus sylvestris-miocenica* ZABLOCKI, p. 183, pl. 7, fig. 7

Material: 2 cone impressions (Sat. 2280, 2283)
Description: Cones oblongo-ovate, the apex narrower and slightly curved, the base rounded or truncate, symmetrical. Cone scales compact, placed in chess-board order. Apophysis rhom-shaped, flat, with radial bands. Umbo annular, small, flat, subconcave. Mucro very short, faintly visible.
Dimensions: 6-7 cm in length and 2.6 cm in width.
Remarks: This species is very similar to *P. thomasiana* (GOEPPERT) REICHENBACH, but it differs in it flat apophysis which has bands. Both species refer to the series Nigrae NOVAK (MAI 1986).
In respect to morphology, *P. hampeana* has cones similar mainly to those of the recent Japanese species *P. thunbergiana* FRANCO (MAI 1986).
Geograpic and stratigraphic distribution: The area of the species covers Central Europe; ours is the first find from the south-eastern part ot the continent. Its stratigrapic amplitude is Middle-Upper Miocene (MAI 1986). It has been found for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

2.1.2. *Pinus brevis* LUDWIG

Plate 1, figs. 3 and 6

1857. *Pinus brevis* LUDWIG, p. 89, pl. 19, fig. 1
1887. *Pinus montana-fossilis* GEYLER & KINKELIN, p. 35, pl. 1, fig. 1
1968. *Pinus parabrevis* KILPPER, p. 215, pl. 41, figs. 6-11

Material: 2 cone impressions (Sat. 2134, 2367).
Description: Cones ovate, the apex shortly narrowed, rounded, the base asymmetrically, rounded. Apophysis widely rhomb-shaped to polygonal, slightly curved. Umbo subconcave with a slightly expressed annular swelling. Mucro small, excentrically located.
Dimensions: 5-6 cm in length and 2-3.2 cm in width.
Remarks: The species described is very similar to *P. parabrevis* (KILPPER 1968) and is most probably taxonomically a form of *P. brevis* with a bent apophysis and with no annular swelling on the umbo. Among the recent species, *P. mugo* TURRA and *P. uncinata* MIRB. have most simalar cones.
Geographic and stratigraphic distribution: The area of the species up to now covers western and Central Europe. Its find in Bulgaria is the first proof for the south-eastern European part of the area. Its stratigraphic amplitude is Sarmatian-Early Pliocene (MAI 1986). It has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

Section *PINASTER* LOUDON

2.1.3. *Pinus neptuni* (UNGER) PALAMAREV comb. nov.

Plate 2, figs. 1-2

1850. *Pinites neptuni* UNGER, p. 368 (nomen)
1852. *Pinites neptuni* UNGER, p. 29, pl. 15, figs. 4-5

Material: 3 impressions of needles in bundles of two on brachyblast (Sat. 1486a, 1486b, 1928).
Description: Needles straight, long, relatively thick, in bundles of two on brachyblast, in cross section with a crescent shape.
Dimensions: 12-15 cm long and 1-2 mm wide. The length of the brachyblast about 2 cm.
Remarks: The defined two needles pine is notable for its long and solid needles. On the basis of these features the fossil species may be referred to the Mediterranean *P. pinaster* AIT.. UNGER (1852) compares the species to the recent Mexican species *P. cembroides* ZUCC., whose needles are most often in bundles of three, their length not exceeding 4 cm.
MAI (1990) suggests a new interspecific classification, including section PINASTER into section PINUS with a rank of subsection PINASTRES.
Geographic and stratigraphic distribution: The area of the species, up to now, has been located in the north-western part of the Balkan Pensinsula (UNGER 1852). Its new find widens its distribution. The stratigraphic amplitude of the species is Middle Miocene. It has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

Section *HALEPENSIS* LOUDON

2.1.4. *Pinus salinarum* (PARTSCH) ZABLOCKI

1847. *Pinites salinarum* PARTSCH in ENDLICHER, p. 288 (nomen)
1852. *Pinites aequimontanus* GOEPPERT in UNGER, p. 87
1928. *Pinus salinarum* (PARTSCH) ZABLOCKI, p. 184, pl. 7, figs. 1-4
1959. *Pinus moldavica* ANDREEV, p. 148, figs. 1-4

Material: 3 cone impressions (Sat. 1782a, 1782b).
Description: Cones oblongo-ovate, apex acuminate, base truncate, asymmetrical. Apophysis irregularly and roundedly rhomb-shaped, flat, its upper margin rounded with a transverse and a longitudinal carina. Umbo small, round. Mucro very small, faintly visible.
Dimensions: 6-7 cm in length and 2.5-3.0 cm in width.
Remarks: The species is one of the most characteristic representatives of the section *HALEPENSIS* in the Central European Tertiary floras. *Pinus halepensis* MILL. s.l. is the related recent species.
Geographic and stratigraphic distribution: The area of the species, up to now, covers Central Europe and the westernmost parts of East Europe. It has been established for the first time in the fossil flora of Bulgaria. The formation of its area took place in the interval Middle Miocene (Badenian) to Lower Sarmatian (MAI 1986).
Locality: Satovca (Sf).

Section *SULA* MAYR

2.1.5. *Pinus ungeri* STUR

Plate 1, figs. 7-8

1867. *Pinus ungeri* STUR, p. 149
1986. *Pinus ungeri* STUR; MAI, p. 578, pl. 44, figs. 1-6; textfig. 1

Material: 2 cone impressions (Sat. 1782a, 1782b).
Description: Cones oblongo-ovate to cylindrical. Apex gradually narrowed, acuminate. Base rounded. Apophysis convex, rhomb-shaped, at the base of the cone widely rhomb-shaped and at the apex elongated rhomb-shaped with a clearly expressed carina along the axis of the apophysis. Umbo oval with an annular swelling. Mucro faintly visible.
Dimensions: 12 cm in length and 4-5 cm in width.
Remarks: *Pinus strozii* GAUDIN, *P. vexatori* GAUDIN and *P. timleri* STUR also belong to the form circle of the species described (MAI 1986), but they all have an ovate cone.
Among the recent species, it has greatest affinity to *P. canariensis* SMITH, approaching *P. roxburghii* SARG. to a lesser extent.
Geographic and stratigraphic distribution: The area of the species, up to now, covered limited regions in Central Europe only. Its being found in Bulgaria widens it distribution also over the southeastern part of our continent. The Central European part of the area is of Lower Oligocene age (MAI 1986). It has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

2.1.6. *Pinus princeps* SAPORTA

Plate 2, figs. 3-4

1865. *Pinus princeps* SAPORTA, p. 193, pl. 3, fig. 7

Material: 3 cone impressions (Sat. 2139, 2281, 2428).
Description: Cones oblongo ovate. Apex narrowed, acuminate. Base truncate. Apophysis slightly convex, along the transvers axis elongated rhomb-shaped and with a clearly expressed carina along the same axis. Umbo oval with annular swelling. Mucro small.
Dimensions: about 12 cm in length and 4 cm in width.
Remarks: The studied fossil specimens have no considerable deviations from the type specimen. The morphological features of the fossil cones demonstrate their undoubted affinity to the cones of two similar recent species: *P. canariensis* and *P. roxburghii*, belonging to the same section. Obviously, *P. ungeri* and *P. princeps* are also two species of the same section.
Geograpic and stratigraphic distribution: The area of *P. princeps*, up to now, covered only regions of western Europe (SAPORTA 1865). Its being found in Bulgaria registers a new areal part, which was formed chronologically after the West European one, the latter being of Late Oligocene age. The species has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

TSUGA CARRIERE

2.1.7. *Tsuga moenana* KIRCHHEIMER

Plate 1, fig. 1

1935. *Tsuga moenana* KIRCHHEIMER, p. 433, pl. 5, fig. 1
1964. *Tsuga moenana* KIRCHHEIMER; MAI, p. 14, pl. 1, fig. 2

Material: 2 cone impressions (Sat. 340a, 340b).
Description: Cones oblongo-ovate, at apex and base rounded, composed of about 15 cone-scales with a widely and roundedly triangular shape. The scales are longitudinally shallowly furrowed.
Dimensions: 3.5 cm in length and 2.0 cm in width.
Remarks: In the Tertiary flora of Europe the species *T. europaea* MENZEL is widely distributed, but it is distinguished by its smaller, narrow-ovate cones, constituted of a larger numer of rounded cone-scales. Among the recent species, *T. canadensis* (L.) CARR. and *T. heterophylla* (RAF.) SARG. have cones with the most similar structure.
Geographic and stratigraphic distribution: The area of *T. moenana*, up to now, covers only Central Europe, its age being Middle Miocene (MAI 1964). The new find has been the first one from outside that area. It has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

2.2. Taxodiaceae

SEQUOIA ENDLICHER

2.2.1. *Sequoia abietina* (BRONGNIART) KNOBLOCH

Plate 1, figs. 9-11

1822. *Phyllites abietina* BRONGNIART in CUVIER, p. 360, pl. 11, fig. 14
1828. *Taxites langsdorfii* BRONGNIART, p. 108 (nomen nudum)
1855. *Sequoia langsdorfii* HEER, p. 54, pl. 20, fig. 2
1964. *Sequoia langsdorfii* HEER; PALAMAREV, p. 12, pl. 3, figs. 1-2
1964. *Sequoia abietina* (BRONGNIART) KNOBLOCH, p. 601
1984. *Sequoia langsdorfii* (BRONGNIART) HEER; USUNOVA, p. 73, fig. 1: 2-3

Material: 5 impressions of leafed branches with phytoleims and 2 cone impressions (Sat. 1197a, 1197b, 1198, 1783a, 1783b, 1784a, 1784b).
Remarks: The species has been established many times in the fossil flora of Bulgaria; it has only been figured in this paper.
Geographic and stratigraphic distribution: The area of the species covers Europe (except it northern parts) and West and Central Asia; its stratigraphic amplitude being Early Oligocene - Late Pliocene (COCIEVA 1985).
Locality: Satovca (Sf).

CRYPTOMERIA D. DON

2.2.2. *Cryptomeria rhenana* KILPPER

Plate 2, figs. 5-8; pl. 3, figs. 1-3, 5-6

1968. *Cryptomeria rhenana* KILPPER, p. 104, pl. 34, figs. 23-30; pl. 35, figs. 1-8; pl. 38, figs. 3-4; textfigs. 1-4

Material: 5 impressions of leafed branches with phytoleims and 3 cone impressions (Sat. 1032a, 1032b, 1447a, 1447b, 1484, 1499a, 1499b, 4000).
Description: The leafed branches are of varied order: marginal and intermediate braches of the axes; the marginal ones with thick axes and bigger, more densely placed needles. The leaves sickle-shaped, spirally placed, awl-shaped, with an entire margin and an alternation of longer and shorter ones; sessile and laterally folded inwardly.
Dimensions: Length of the leaves from 0.9 to 1.5 cm and width from 0.1 to 0.2 cm.

The female cones big, apically placed, almost globular. The cone-scales numerous, woody, attached at the base, constituted of a covering and a fruiting part; the fruit scales toothed at the apex. The diameter of the cones ranges from 1.5 to 2.5 cm.
Cuticular structure: The leaves are amphistomatic; the stomata on the lower surface placed in two rows and those on the upper surface in a single row. The epidermal cells are irregularly elongated with straight or slightly curved anticlinal walls; their length always exceeds their width, their dimensions are 25 - 65.75 μm length and 8.75 - 19.75 μm width. The stomatal apparatus is amphicyclic; the subsidiary cells are 4-6, forming an entire or an interrupted ring, two of the cells always polarly placed. The subsidiary cells with dimensions of 15 to 32.55 μm length and 6.25 to 17.55 μm width. The guard cells with dimensions 10.0 dto 15.0 μm length and 6.0 to 17.55 μm width.
Remarks: The described species is the only one known from the Tertiary flora of Europe. It has a genetic relation with the only recent species *C. japonica* D. DON. An adequate proof for that are the morphological and anatomical similarities in the structure of the vegetative and generative organs of both species.
Geographic and stratigraphic distribution: The area of *C. rhenana*, up to now, is mainly restricted to the territory of the western regions of Germany (KILPPER 1968). The Bulgarian find delineates a second partial area of the species. The age of its West European part is Upper Miocene (KILPPER, op.c.). The species has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

2.3. Sciadopityaceae

SCIADOPITYS SIEBOLD et ZUCCARINI

2.3.1. *Sciadopitys* cf. *marcodurensis* WEYLAND, KILPPER et BERENDT

Plate 4, fig. 9

1967. *Sciadopitys marcodurensis* WEYLAND, KILPPER et BERENDT, p. 159, pl. 30, figs. 31-35; pl. 31, figs. 36-38

Material: 7 impressions of leafed branches with phytoleims (Sat. 1876, 1879, 1928, 1929, 1930, 2312, 2457).
Description: Leaves placed in whorls of 12-15, linear with an entire margin and a midrib; apex shortly narrowed and rounded; base sessile.
Dimensions: 8-10 cm in long and 0.2 cm wide.
Cuticular structure: It is not well preserved; just isolated elements are to be observed, on the basis of which it has been roughly restored. The leaves are epistomatic; the epidermal cells are rectangular; the stomata monocyclic, placed on a row along the leaf midrib. The subsidiary cells about 7-8, with papilles.
Dimensions of the stomata: 25.0 x 9.38 μm.
Remarks: Two species are known from the European Tertiary floras, described on the basis of leaf remains: *S. tertiaria* MENZEL and *S. marcodurensis*. The former is distinguished by considerably shorter leaves (up to 3.8 cm) and strange anatomy; the latter with strongly papillous epidermis and granular cutinized anticlinal walls of the epidermal cells. These differences testify to a certain deviation of the Bulgarian specimens, due to which their species position remains uncertain.
The fossil taxon has an undoubted relation to the only recent Japanese species *S. verticillata* (THUNB.) SIEBOLD et ZUCCARINI.
Geographic and stratigraphic distribution: The area of *S. marcodurensis* is, for the time being, mainly restricted to the territory of Western Europe; its stratigraphic range being Upper Miocene (WEYLAND et al. 1967). The new find delineates a second partial area of the species. It has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

2.4. Cupressaceae

LIBOCEDRITES ENDLICHER

2.4.1. *Libocedrites salicornioides* (UNGER) ENDLICHER

Plate 3, figs. 4, 7; pl. 4, fig. 8

1838. *Hellia salicornioides* UNGER, p. 375 (nomen)
1847. *Libocedrites salicornioides* (UNGER) ENDLICHER, p. 275
1987. *Libocedrites salicornioides* (UNGER) ENDLICHER; PALAMAREV & PETKOVA, p. 28, pl. 6, figs. 10-12

Material: 4 impressions of leafed branches with phytoleims (Sat. 4002, 4003, 4004, 4005).
Remarks: The species has been characterized in detail in respect to morphology by PALAMAREV & PETKOVA (op.c.). However, the Satovca finds present well preserved phytoleims, showing the epidermis structure of the leaves.
Cuticular structure: Epidermal cells isodiametric polygonal, most often 5 or 6-angled. Their aniclinal walls undulating; the dimensions of these cells vary: they are 25.0 to 40.0 μm long and 15.0 to 30.0 μm wide.
Stomatal apparatus monocyclic; subsidiary cells 4-6, having dimensions of 11.25-42.55 μm x 6.25-17.55 μm; the stomata having dimensions of 12.0-18.75 μm x 5.55-15.0 μm.
Remarks: KVACEK (1989) suggests a new solution regarding the taxonomic position of the cited species. According to him, it should be referred to the genus *Tetraclinis* MASTERS, respectively *T. salicornioides* (UNGER) KVACEK. To our opinion, such a solution is hasty,

due to the following reasons:
a) the facial and the marginal leaves of *Tetraclinis* are narrow-elongated and at the apex they are compactly sessile to the axis and to each other;
b) the cones of *Tetraclinis* are globular and are constituted of cone-scales shortly acuminate at the apex;
c) the epidermal cells of *Tetraclinis* are elongated and their length is always greater than their width.
Geographic and stratigraphic distribution: The area of the species covers Europe, West and Central Asia; its stratigraphic range being Middle Eocene - Upper Pliocene (PALAMAREV & PETKOVA 1987).
Locality: Satovca (Sf).

TETRACLINIS MASTERS

2.4.2. *Tetraclinis wandae* ZABLOCKI

Plate 4, figs. 4-5

1928. *Tetraclinis wandae* ZABLOCKI, p. 188, pl. 8, figs. 10-14

Material: 2 cone impressions (Sat. 4008a, 4008b).
Description: Cones globular, very small, constituted of 4 woody scales, about 1.5 mm long and placed oppositely (in a cross). the cone-scales widely and obtusely ovate, with no acuminate part at the apex; apically with a very small umbo.
Remarks: The species described is very similar to the other Tertiary and more widely distributed representative of the genus *Tetraclinis*, *T. brachyodon* (BRONGNIART) MAI et WALTHER. Yet, the latter has larger cones and cordate scales with a shortly acuminate apex. The fossil cones of both species are, in certain individual features, morphologically similar to the only recent Mediterranean species *T. articulata* (VAHL.) MASTERS.
Geographic and stratigraphic distribution: The area of *T. wandae*, up to now, is restrited to regions of West and Central Europe; its occurrence being connected with the Middle and Upper Miocene (SCHLOEMER-JÄGER 1960). The new find has been the first one from outside that area. The species has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

THUJA LINNÆ

2.4.3. *Thuja saviana* GAUDIN

Plate 4, figs. 1-2

1859. *Thuja saviana* GAUDIN in GAUDIN & STROZZI, p. 12, p.1, figs. 4-19; pl. 2, figs. 6-7
1859. *Thuja goeppertii* SISMONDA, p. 7, pl. 3, figs. 5-6
1929. *Thuja occidentalis* L.; STOJANOFF & STEFANOFF, p. 24, pl. 3, fig. 9; textfig. 5: 1
1934. *Thuja* sp. aff. *T. occidentalis* L.; STEFANOFF & JORDANOFF, p. 6, pl. 3, fig. 4; pl. 4, figs. 12-14
1957. *Thuja saviana* GAUDIN; BERGER, p. 9, pl. 1, figs. 1-8
1972. *Thuja* cf. *occidentalis* L.; SHTEPHYRTZA, p. 60, pl. 13, figs. 2-3; pl. 11, fig. 5

Material: 9 impressions of leafed branches with phytoleims (Sat. 1628, 1828, 1829, 1831, 2283, 2284, 2328, 2332, 2424).
Description: The morphology of the taxon has been analyzed by STEFANOFF & JORDANOFF (1934). The new find gives certain information also for the structure of the leaf epidermis.
Cuticular structure: The epidermal cells are elongated-rectangular with slanting anticlinal walls, wedged into each other in a peculiar way at the same time.
Dimensions of the epidermal cells: 25.00 to 62.50 µm long and 7.50 to 13.75 µm wide.
Stomatal apparatus regularly rounded, monocytic; subsidiary cells 4-6. The stomata having dimensions of 16.06 x 6.96 µm.
Remarks: In its morphological and anatomical features the fossil taxon is very similar to the recent North American *T. occidentalis* L.
Geographic and stratigraphic distribution: The area of the fossil species covers the Apenninian and the Balkan Peninsulas, Moldavia and South-West Asia (BERGER 1957; SHTEPHYRTZA 1972); stratigraphically being tied to the Middle Miocene and the Pliocene.
Locality: Satovca (Sf).

2.5. Taxaceae

AMENTOTAXUS PILGER

2.5.1. *Amentotaxus* cf. *gladifolia* (LUDWIG) FERGUSON, JÄHNICHEN et ALVIN

Plate 4, figs. 3, 6-7

1858. *Pteris gladifolia* LUDWIG, p. 154, pl. 33, figs. 11-11a,b
1935. *Amentotaxus florinii* KRÄUSEL, p. 137, figs. 1-8
1978. *Amentotaxus gladifolia* (LUDWIG) FERGUSON et al., p. 187, pl. 24, fig. 1; pl. 25, figs. 1-3; pl. 27, figs. 1-3; pl. 28, fig. 1; pl. 30, figs. 1-3; pl. 31, figs. 1-2; pl. 32, figs. 1-2; pl. 33, figs. 1-4; pl. 34, fig. 1;

pl. 35, fig. 1; pl. 36, figs. 1-6; pl. 37, figs. 1-3; pl. 38, figs. 1-2; pl. 39, figs. 1-2

1990. *Amentotaxus gladifolia* (LUDWIG) FERGUSON et al.; JÄHNICHEN, P. 69, pl. 1, figs. 1-7; pl. 2, figs. 1-3

Material: 3 leaf impressions with phytoleims (Sat. 2407a, 2407b, 2408).
Description: Leaves linear-lanceolate, slightly curved with an entire margin, midrib and two parallel bands (the stomata are placed in them) along the leaf margins; the apex is gradually narrowed, acuminate; the base wedge-shaped, sessile.
Dimensions: 6-7.5 cm long and 2.5 to 3.5 cm wide.
Cuticular structure: Upper epidermis constituted of rectangular or polygonal cells, placed in bands. Lower epidermis near stomata bands constituted of rectangular or polygonal cells with slightly undulating walls. Stomata monocyclic; subsidiary cells 4-10, 2 or 4 polarly and 4 or 6 laterally placed.
Dimensions of stomata: 32.33-56.55 μm long and 15.67-32.33 μm wide.
Remarks: The specimens studied have a poorly preserved epidermis structure, which makes it impossible to provide a more accurate comparison to the type material (FERGUSON et al. 1978). According to the quoted authors, the fossil species has a morphological and anatomical affinity to the recent South-East Asian species *A. cathayensis* LI, *A. yunnanensis* LI and *A. formosana* LI (FERGUSON, op.c.).
Geographic and stratigraphic distribution: The area of *A. gladifolia* covers regions in West and Central Europe; its south-easternmost part, up to now, being the territory of Northern Roumania. With respect to stratigraphy, the area is formed in the interval Paleocene - Pannonian, but its widest development is connected with the Middle and Late Miocene (FERGUSON et al. 1978; LANCUCKA-SRODONIOWA et al. 1981). The species has been established for the first time in the fossil flora of Bulgaria.
Locality: Satovca (Sf).

3. Remarks on the systematic composition of the Conifers and the distribution of species

A characteristic feature of the established conifers is its varied and considerably rich composition. It consists of 14 species of Class Pinopsida, belonging to 9 genera: *Pinus*, *Tsuga*, *Sequoia*, *Cryptomeria*, *Sciadopitys*, *Libocedrites*, *Tetraclinis*, *Thuja*, and *Amentotaxus*. The greatest number of species (6) is presented by the genus *Pinus*, all the rest being represented by 1 species. The genus *Amentotaxus* has been proved in the Bulgarian fossil flora for the first time.
Furthermore, 11 of the species have also been discovered for the first time in the composition of the Bulgarian Tertiary flora, their finds considerably widening their areas in Europe. Belonging to this category are: *Pinus hampeana*, *P. ungeri*, *P. princeps*, *P. salinarum*, *P. brevis*, *P. neptuni*, *Tsuga moenana*, *Cryptomeria rhenana*, *Sciadopitys* cf. *marcodurensis*, *Tetraclinis wandae*, and *Amentotaxus* cf. *gladifolia*.
Alongside the above mentioned pecularities we should like to draw special attention to the diversity of the genus *Pinus* (Table 1).

Table 1: The genus *Pinus* L. in the paleoflora of Satovca

Subgenus	Section	Fossil species	Recent species
Pinus	*SYLVESTRES*	*P. hampeana*	*P. thunbergiana*
		P. brevis	*P. mugo*
			P. uncinata
	SULA	*P. ungeri*	*P. canariensis*
		P. princeps	*P. roxburghii*
	HALEPENSIS	*P. salinarum*	*P. halepensis*
			P. brutia
			P. pithyusa
	PINASTER	*P. neptuni*	*P. pinaster*

The systematic composition shows that the Tertiary pines of the Satovcan paleoflora are mainly connected with the circle of affinity of the European-Canarian-Himalayan species group and to a much lesser extent with the East Asian species group.
As regards the area, only two of the established species may be defined as Paneuropean: *Sequoia abietina* and *Libocedrites salicornioides*. The rest of the species have a more restricted distribution, a part of them having a broken West-Southeastern European area - *P. princeps*, *Cryptomeria rhenana*, and *Sciadopitys marcodurensis* - and a second one having a Central-Southeastern European area - *P. hampeana*, *P. salinarum*, *P. brevis*, *P. ungeri*, *Tsuga moenana*, and *Tetraclinis wandae*. For all of them the studied paleoflora proves for the first time the existence of a disjunction.
The finds established so far of *Pinus neptuni* show a Balkan Miocene area while thos of *Thuja saviana* indicate an Apenninian-Balkanian-Moldavian-Georgian area of Mio-Pliocene age.
The distribution of *Amentotaxus gladifolia* is prominent with a number of yet more specific features. Till recently that species was considered a characteristic European Tertiary floristic element (FERGUSON et al. 1978), having a Paleocene-Pannonian range. Yet, JÄHNICHEN (1990) on the basis of some new investigations, comes to the conclusion that it refers to a North American-European species, whose area was formed in the interval Upper Albian-Pannonian, the disjunction taking place in the Late Cretaceous. To our opinion, the North American materials are somewhat different with respect to leaf morphology and anatomy, those differences, mentioned by JÄHNICHEN (1990: 69-70) himself, giving us grounds, together with the peculiarities in the distribution and the age of the area of the North American taxon, to regard the case as concerning a vicarious taxon with a

greater geological age and a differentiated Pacific-North American (Mandreanean) area, which according to the rules of nomenclature, should be quoted under the name of *Amentotaxus californica* (POTBURY) JÄHNICHEN (= *Cephalotaxus californica* POTBURY).

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5. Explanation of Plates

The specimens are deposited in the Palaeobotanical Collections of the Botanical Institute of Bulgarian Academy of Sciences (numbers prefixed SAT.).

Plate 1

Fig. 1. *Tsuga moenana* KIRCHHEIMER. - Cone; x 2.

Fig. 2. *Pinus salinarum* (PARTSCH) ZABLOCKI. - Cones; 1:1.

Figs. 3,6. *Pinus brevis* LUDWIG. - Cones; 1:1.

Figs. 4-5. *Pinus hampeana* (UNGER) HEER. - Cones; 1:1.

Figs. 7-8. *Pinus ungeri* STUR. - Cones; 1:1.

Figs. 9-11. *Sequoia abietina* (BRONGNIART) KNOBLOCH.

9: Cone; 1:1.

10: Leafed braches; 1:1.

11: Lower epidermis structure of the needles; x 400.

PLATE 1

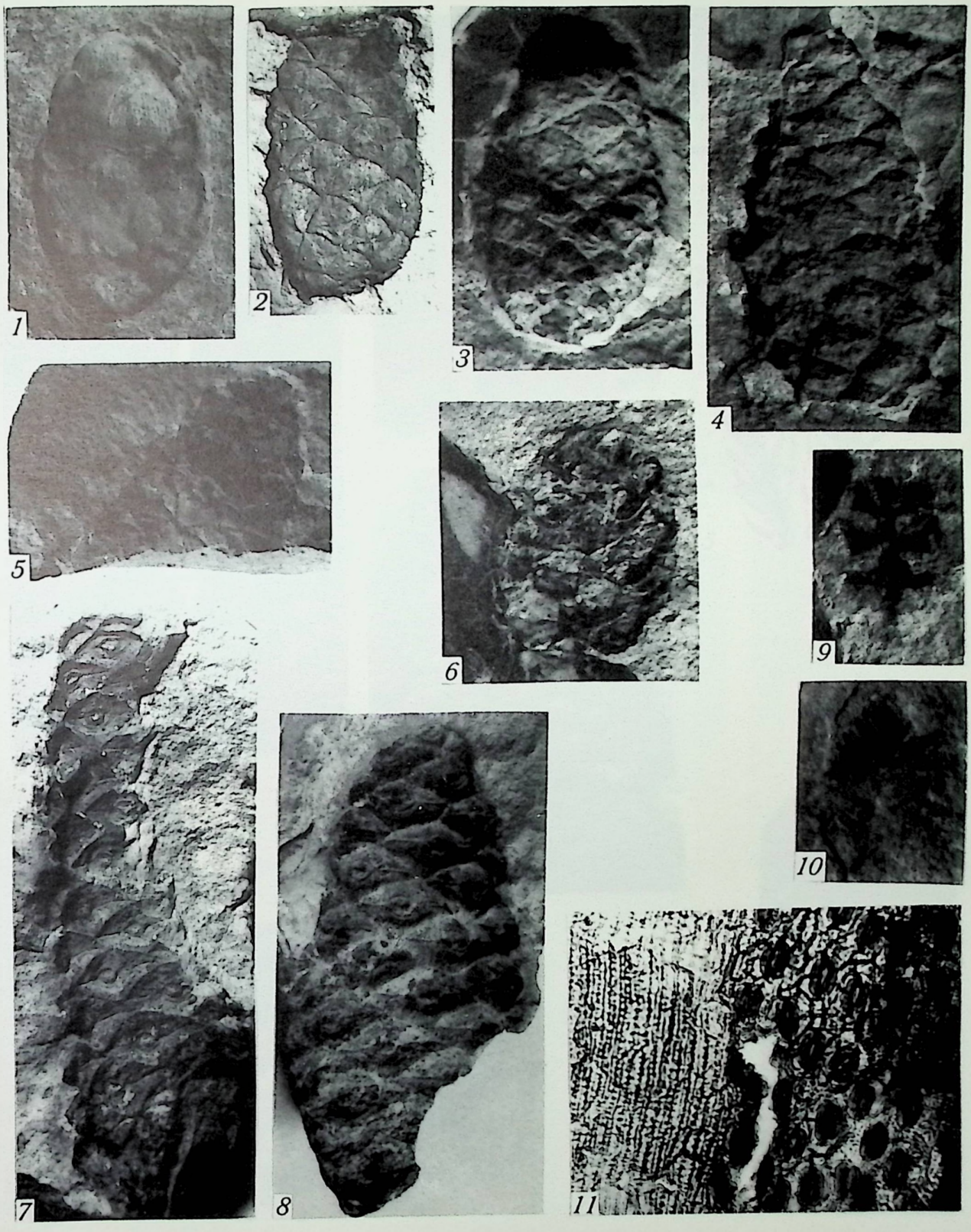

Plate 2

Figs. 1-2. *Pinus neptuni* (UNGER) PALAMAREV.
Needles in bundles of two on brachyblasts; 1:1.

Figs. 3-4. *Pinus princeps* SAPORTA. - Cones; 1:1.

Figs. 5-8. *Cryptomeria rhenana* KILPPER.

5,7,8: Leafed branches; 1:1.

6: Cone; 1:1.

PLATE 2

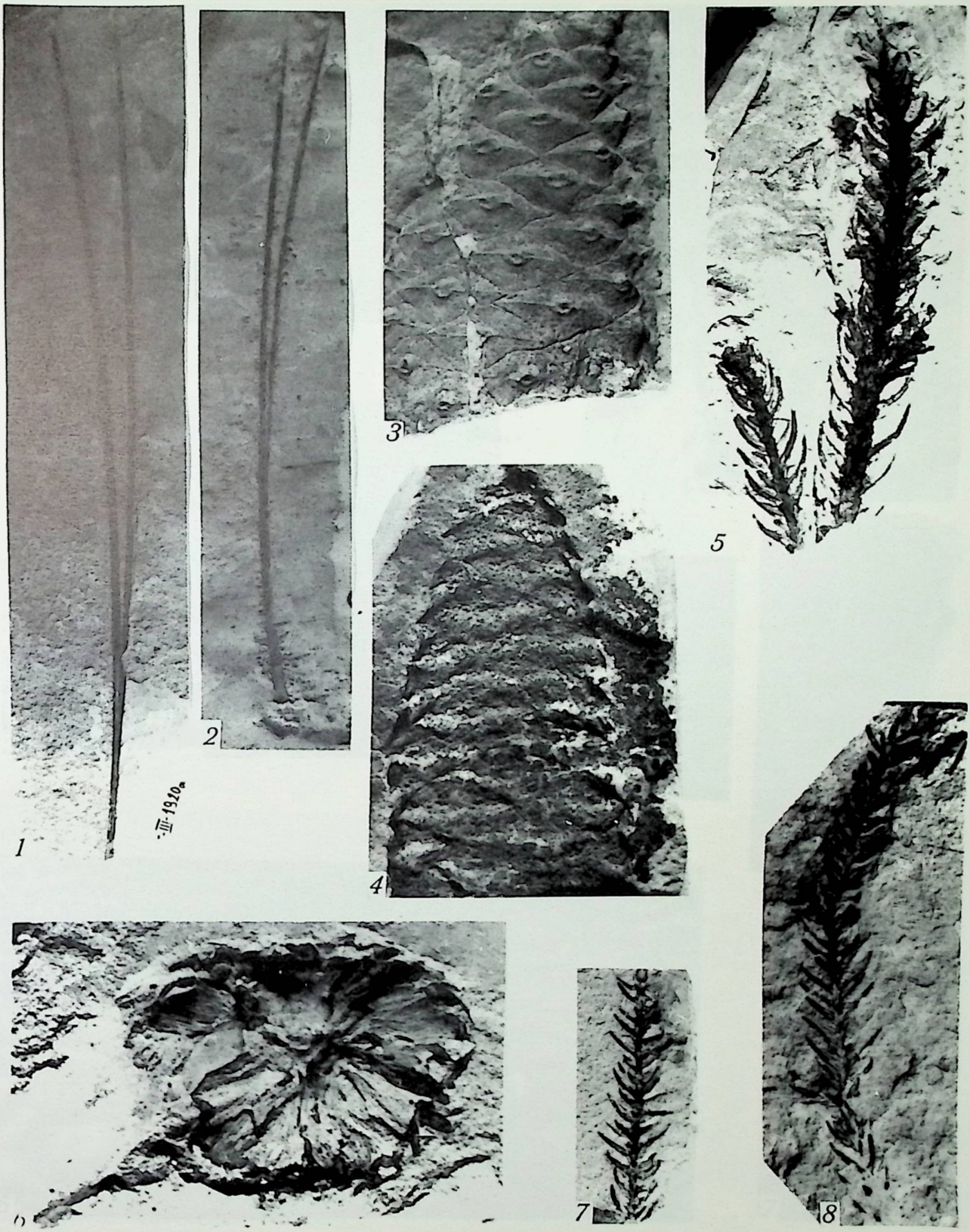

Plate 3

Figs. 1-3, 5-6. *Cryptomeria rhenana* KILPPER.

1,3,6: Lower epidermis structure of the needles; x 800.

2,5: Cones; 1:1.

Figs. 4, 7. *Libocedrites salicornioides* (UNGER) ENDLICHER.

Leafed braches; 1:1.

PLATE 3


1


2

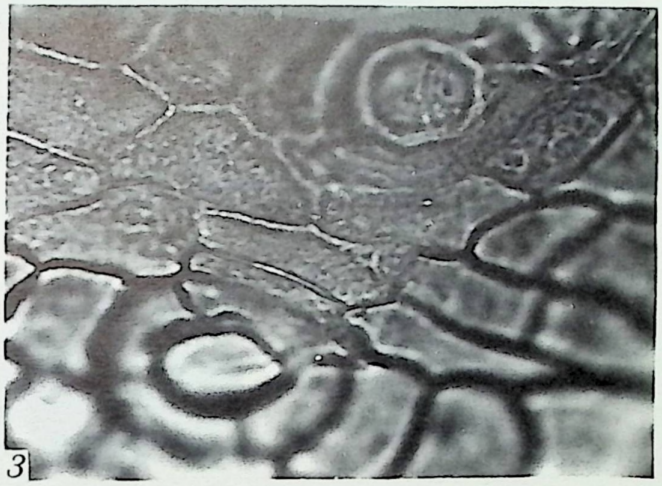
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Plate 4

Figs. 1-2. *Thuja saviana* GAUDIN. - Leafed branches; 1:1.

Figs. 3,6-7. *Amentotaxus* cf. *gladifolia* (LUDWIG) FERGUSON, JÄHNICHEN & ALVIN. Needles; 1:1.

Figs. 4-5. *Tetraclinis wandae* ZABLOCKI. - Cones; 1:1.

Fig. 8. *Libocedrites salicornioides* (UNGER) ENDLICHER. Lower epidermis structure of the leaves; x 800.

Fig. 9. *Sciadopitys* cf. *marcodurensis* WEYLAND, KILPPER & BERENDT. Leafed branches with needles in whorles; 1:1.


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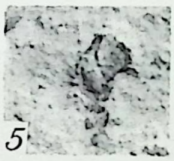
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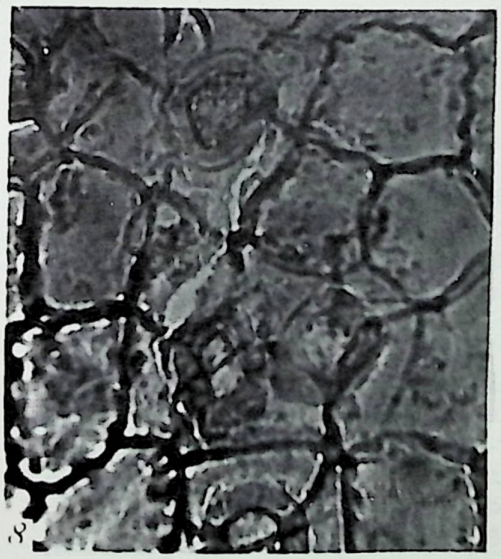
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